WATERFOWL HABITAT MANAGEMENT IN THE TENNESSEE VALLEY

SPECIAL SCIENTIFIC REPORT: WILDLIFE No. 7

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

United States Department of the Interior
Oscar L. Chapman, Secretary

Fish and Wildlife Service
Albert M. Day, Director

Explanatory Note

The series, Special Scientific Reports, embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for the official use of Federal, State or cooperating agencies and in processed form for economy and to avoid delay in publication.

Washington, D. C.
November 1950

United States Department of the Interior
Oscar L. Chapman, Secretary
Fish and Wildlife Service
Albert M. Day, Director

Special Scientific Report - Wildlife

No. 7

WATERFOWL HABITAT MANAGEMENT IN THE TENNESSEE VALLEY

A Summary of Management Procedures

Found Applicable in this River-Basin Development

By

John H. Steenis
Wildlife Research Biologist

CONTENTS

WATERFOWL HABITAT MANAGEMENT IN THE TENNESSEE VALLEY[1]

Opportunities and Limitations

This report is concerned primarily with problems involved in developing waterfowl resources within the limitations imposed by major objectives of the TVA (Tennessee Valley Authority). In a large measure it deals with the coordination of wildlife work with engineering. Some of the principles and practices used in improving waterfowl habitat in this area may be applicable to basin programs elsewhere in the nation.

The watershed of the Tennessee River became the site for a regional development project by the Tennessee Valley Authority Act of 1933. In this Act, Congress directed that the Tennessee River be developed primarily for flood control, navigation, and hydroelectric power. Secondary objectives were designated as promotion of agriculture, forestry, malaria control, fish and wildlife conservation, and recreation. To accomplish these multiple purposes TVA built a series of major lakes including nine reservoirs on the Tennessee River and nineteen tributary impoundments.

To capitalize on waterfowl potentialities in the series of water bodies impounded by the TVA, the Wheeler National Wildlife Refuge was established by the U. S. Fish and Wildlife Service in 1939. This refuge is located on the Wheeler Reservoir in the north central part of Alabama. Its success in attracting waterfowl encouraged the creation of the Tennessee National Wildlife Refuge, established in 1945 on Kentucky Lake, the largest of the down-stream impoundments. In addition, successful waterfowl habitat developments were made on the Kentucky Woodlands National Wildlife Refuge, bordering the Kentucky Reservoir. The State of Tennessee, with TVA cooperation, has made improvements on waterfowl units on the Kentucky and Chickamauga reservoirs with excellent response from ducks and geese. Alabama and Kentucky are now engaged in similar developments in the TVA area. Success in all these projects has depended, and will continue to depend, largely on cooperation received from TVA.

The response of waterfowl to those parts of the TVA impoundments especially developed and managed for waterfowl use, has been very impressive. The influx of many thousands of ducks and geese into the TVA area -- with populations of over 100,000 wintering birds in recent years -- represents a substantial expansion of wintering territory. A typical example of the extent to which waterfowl have been drawn into this region is shown by

---

[1] The writer is indebted to Dr. Clarence Cottam for advice and assistance in these investigations and to Dr. A. C. Martin for aid in preparation of this report.

counts on a single reservoir -- the Wheeler unit. Here, as on most new impoundments, there was a spectacular initial response for which allowance must be made. Waterfowl are likely to be particularly attracted by the wealth of seeds and other food materials present on a lake bed prior to flooding. Unless good food resources are made available in such places during following seasons, a drastic drop in waterfowl patronage is sure to follow. Over 60,000 ducks and geese were reported wintering on Wheeler Lake in 1937-38, the first two years of flooding. In the next season the population dropped sharply -- only 2,000 were reported wintering on the reservoir. By the 1944-45 season and following, substantial habitat improvements on the refuge part of the Wheeler Reservoir resulted in populations of more than 30,000 wintering ducks and geese. However, on the unimproved remainder of the reservoir -- approximately two-thirds of the whole -- only 200 to 300 waterfowl were present. This is an index of the extent to which large waterfowl populations now patronizing the TVA areas have been attracted by habitat improvement. Unless there had been effective capitalization of potentialities on the TVA reservoirs, there would be only a small fraction of the present extent of waterfowl use.

In its initial stages, the Wheeler National Wildlife Refuge served as a proving ground for coordinating waterfowl management with TVA's regional management. The aim of the refuge was to promote wildlife development without impeding other TVA functions and, in particular, malaria control activities. This necessitated inter-agency coordination of land and water management in those areas where wildlife was to receive consideration. As a consequence, certain tracts were set aside for a combination of agricultural and wildlife purposes and many other activities were handled on a cooperative basis.

From the first, serious coordination problems were apparent. TVA's use of water for its primary functions of flood control and hydroelectric power was inclined to be adverse to waterfowl welfare because of unfavorable timing of draw-downs and refloodings. Consequently, there often was inadequate water on refuge units when birds arrived in the fall. Some conflicts of this type undoubtedly could have been avoided by specific planning while TVA was still in the blueprint stage.

Coordinating Waterfowl Habitat Management with Malaria Control Operations

The biggest coordination problem has been that of adjusting waterfowl habitat management to malaria control programs. In the TVA basin, the important waterfowl and malaria control areas invariably coincide. Consequently, cooperative field investigations were made by representatives of TVA (mainly by the Departments of Health and Safety and of Forestry Relations), U. S. Public Health Service, U. S. Fish and Wildlife Service, and U. S. Bureau of Entomology and Plant Quarantine. The joint studies resulted in new techniques and served as a basis for integrating programs of waterfowl and fisheries management with malaria control operations. Also, they made it evident that some of the conflicts were more apparent than real and that there were several measures of mutual advantage for both malaria control and wildlife (Wiebe and Hess, 1944).

Several practices of the Health and Safety Department of TVA have definite bearing on wildlife welfare. These consist of operations for controlling the malaria mosquito larva (mainly *Anopheles quadrimaculatus*) by reducing its breeding environment and include the following: Water fluctuation, larvicidal treatment, plant control, shoreline conditioning, cutting and filling, diking and dewatering, and land-use restriction.

Water Level Fluctuation

The manipulation of water levels is considered an essential procedure for preventing the development of favorable breeding habitat for the malaria mosquito (Hall et al, 1946). The program calls for high water levels well above normal, in the spring of the year in order to strand floatage. This is followed by a period of constant water level until breeding of the malaria mosquito has passed the initial stage. Holding a constant water level restricts the zone of amphibious vegetation and contributes to malaria control by suppressing coppice growth. The constant-level period is followed by a weekly cycle of fluctuation. Later in the season, the weekly raising and lowering of the water level is combined with recession of about 1/10 of a foot during each week. On all of the main-river reservoirs with the exception of the lowest impoundment, Kentucky Lake, this cyclical-recessive fluctuation is conducted through the summer into September when the breeding of the malaria mosquito ceases. On Kentucky Lake there is a gradual draw-down rather than a fluctuated one.

The draw-down of water for malaria control results in stranding marginal vegetation some of which might otherwise be useful to waterfowl. It also prevents the growth of submerged plants. In this respect, malarial operations might well be subject to undue criticism as inimical to waterfowl. Since, however, a later and more drastic draw-down for power and flood control occurs before waterfowl use of these TVA lakes, dewatering and stranding of vegetation takes place regardless of malaria control programs.

Larvicidal Treatment

Larvicidal control of *Anopheles* has involved the use of oil, Paris green, and DDT. The oil treatment is definitely harmful to wildlife, but fortunately, high costs of this method have reduced its use to a point where interference with wildlife is negligible. Though in the past some damage has resulted from dusting with Paris green, it has been found that this procedure can be conducted without harm to wildlife. Recently TVA has changed over to nearly exclusive use of DDT, mainly by plane. Under favorable conditions, concentrations as low as .04 pounds to an acre have yielded approximately 90% control of anopheline larvae (Metcalf et al, 1945). However, higher concentrations are necessary when the vegetation is dense. For the most part, DDT is being applied here at the rate of less than .1 of a pound to an acre. This treatment is devastating to larvae of *Anopheles* but fortunately causes little or no effect on other organisms that are important in the food chain for fish and other wildlife in the TVA region.

Plant Control

TVA's control of plants contributing to anopheline breeding, includes numerous species that are also objectionable in waterfowl habitat. Examples of such vegetation are alligator-weed (*Alternanthera philoxeroides*), lotus (*Nelumbo pentapetala*), lizardtail (*Saururus cernuus*), cattail (*Typha latifolia*), giant cutgrass (*Zizaniopsis miliacea*), and water-tolerant woody species, mainly buttonbush (*Cephalanthus occidentalis*) and willow (*Salix* spp.). On the desirability of controlling these pest plants there is complete unanimity, but on the management of other vegetation there is likely to be divergence. The objectives are basically different in that for malaria control, permanent removal of practically all kinds of vegetative growth is desirable, whereas for wildlife, certain kinds of plants need to be controlled if they compete with or preclude the growth of more valuable vegetation. In other words, the object in developing wildlife environment is not so much the destruction of plants as the replacement of pest species by more useful ones.

Shoreline Conditioning

Shoreline conditioning for malaria control in the TVA reservoirs involves several practices. Among these are shoreline grazing, cutting of coppice, and area mowing and burning. These different procedures have diverse effects on waterfowl habitat -- some of them harmful and some beneficial.

Intensive grazing of shoreline vegetation along the zone of fluctuation is harmful since some waterfowl plants, such as wild millet (*Echinochloa crusgalli*), are eaten readily by cattle. Where ducks are to receive consideration in the TVA region, restriction of grazing is advisable.

Control of woody growth by fall and winter cutting is advantageous since it allows herbaceous species to dominate along the reservoir margins. In such herbaceous vegetation there usually are valuable waterfowl plants, such as wild millet, rice cutgrass (*Leersia oryzoides*), smartweeds (*Polygonum* spp.), and chufa (*Cyperus esculentus*). Unfortunately, control of coppice does not contribute to the suppression of weedy herbaceous species, such as purpletop grass (*Panicum agrostoides*), and cattail.

Area mowing and burning of vegetation on reservoir margins may or may not hamper waterfowl, depending on when the operations occur. Early removal of vegetation by these methods before seeds are matured and dropped destroys food supplies for ducks and limits reproduction of duck food plants during future seasons. However, if mowings or burnings are delayed until after the seeds have been dropped, usually after the first frost, the loss of waterfowl food will not be severe.

Investigations made on the Wheeler Refuge in 1942-43 revealed that TVA crews burning the marginal zone of marsh vegetation scared birds away from the immediate locality. Continued observations showed that birds stayed away from these places from a few days to three weeks depending on a variety of factors, such as rising water level, influx of new birds, or other conditions that might cause waterfowl redistribution. Eventually, however, the ducks returned to the burned areas and

used them. TVA crews conducting growth removal on a large area were able to work only a limited part of it at any one time and this allowed birds to shift from one locality to another without being frightened out of the general vicinity. Thus, it can be concluded that the human-interference factor involved in TVA's malaria control operations is not seriously detrimental to waterfowl.

Studies also were made to determine the effects of winter burning of vegetation useful to waterfowl. It was noted that winter burning did not kill perennial vegetation and even in the case of annual growth enough seeds were left on the ground to perpetuate the species the following season. Seed counts were made on a series of square-yard plots before and after burning some of the more valuable duck-food plants, mainly swamp smartweed (Polygonum hydropiperoides), largeseed smartweed (P. pensylvanicum), wild millet, and rice cutgrass. Burnings were classified as being light, medium, or heavy. In light burns, stubbles remained. In medium burns, no stubble was left, but plant debris on the soil surface was not completely destroyed. In the case of heavy burns, all vegetation was destroyed and bare ground was exposed. However, heavy burnings were rare or almost non-existent on the TVA area, so observations on effects were confined to light and medium burns. In these, there was appreciable damage to seeds of native duckfoods. Losses from 9% to 20% occurred in seeds of swamp smartweed and approximately 15% reduction was noted in wild millet. No loss was noted for largeseed smartweed, and very limited injury occurred in rice cutgrass. These studies based on 16 square-yard plots do not justify broad conclusions but they do indicate that light and medium winter burnings though causing some damage, do not severely harm duckfood values of marginal vegetation on reservoirs. Some compensation occurs when such burnings contribute to coppice control. If brush growth were not controlled, the marginal vegetation would include very limited quantities of food for ducks.

Cutting and Filling

TVA's malaria control has included the practice of eliminating gradual-sloping "feather-edge" margins and replacing them with steep ones. Cutting and filling operations involve the use of heavy earth-moving equipment for raising and levelling-off shore platforms or terraces. They are made along the contour in backwater areas where there often are plants such as rice cutgrass, wild millet, and smartweeds which, when flooded, have much wildlife value. Consequently, these physical changes destroy useful vegetation and narrow down considerably the habitat for marginal growths. In one exceptional instance, the cutting and filling operations were advantageous to waterfowl since the shore platform was extensive enough to be seeded with Italian ryegrass (Lolium multiflorum). For the most part, however, these cutting and filling operations for malaria control are harmful to waterfowl interests.

There is a practical alternative to this practice. It is not only favorable to waterfowl but at the same time lessens anopheline breeding habitat. Investigations have indicated that the squarestem spikerush (Eleocharis quadrangulata), a desirable duck food, can be planted successfully

in the marginal zone of reservoirs without adding materially to the malaria-control problem (Hinman, et al, 1941). The naked stems of this species furnish a minimum plant edge or "intersection-line" on the water surface for anopheline breeding and provide a mechanical barrier to oviposition (Rozeboom and Hess, 1944). Consequently, extensive propagation of this species along margins would not only benefit waterfowl but should also serve as an effective substitute for the destructive practice of cutting and filling.

Diking and Dewatering

Another malaria-control procedure that has been used by TVA is the diking-off of troublesome anopheline areas and dewatering by pumping during the malaria mosquito breeding season. This measure can be highly beneficial to waterfowl if reflooding of these units occurs at the conclusion of the malaria season — which is about the time when the fall migration of ducks starts. With suitable timing of reflooding, dewatered areas provide excellent feeding habitat for waterfowl by production of useful native vegetation or agricultural crops. Additional particulars are presented further on in this report.

Land-Use Restrictions

A malaria-control recourse used by TVA is the restriction of land-use within a one-mile zone of reservoirs. People are allowed in this zone only in the daytime during the anopheline breeding season. Large tracts of such restricted land exist on the Kentucky Reservoir within the Kentucky Woodlands National Wildlife Refuge, and another large restricted district is partly within the Tennessee National Wildlife Refuge. Refuge maintenance in these areas is of importance to malaria control because it aids conformity to the human-use restrictions. These areas can be of special value to waterfowl because in them permanent pools for marsh and aquatic habitats can be developed without contributing to the malaria hazard.

Methods of Improving Waterfowl Habitat

Potentialities for waterfowl development on the TVA reservoirs are confined largely to the shallow water sections that occur in the upper part of the impoundment and in embayments of tributary streams. These locations usually offer an advantageous interspersion of land and water due in part to low, ridge-like islands and peninsulas that protrude above water level. In these favorable areas there are several methods of improving habitat for waterfowl. Some are far more important than others. The provision of un-flooded farm crops may result in selective attraction of certain kinds of waterfowl instead of numerous species. This does not result in full waterfowl utilization of an area. In those areas where possibilities are limited, application of all possible methods may be essential for maximum attraction of ducks and geese. Obviously, the combinations of techniques that can be applied will vary for different reservoirs depending on local conditions.

Practical means of habitat improvement applied experimentally by the Fish and Wildlife Service during 10 years of investigations on the lower TVA reservoirs include the following six procedures: (1) Developing sub-impoundments and dewatered

areas; (2) providing non-flooded farm crops; (3) controlling erosion in waterfowl habitat; (4) improving islands and mud flats; (5) managing marginal marsh vegetation; and (6) planting aquatics.

Developing Sub-Impoundments and Dewatered Areas

Two types of sub-impoundments can be used effectively for waterfowl. In one, water of fairly constant level is present continually, while in the other, water levels drop considerably or completely in summer, followed by reflooding during late fall.

Stable-Water Units

In permanent pools or sub-impoundments, useful marsh and aquatic vegetation can be produced. Such developments for waterfowl have to be confined to those sections of the Kentucky Reservoir where human occupancy is limited during the malaria breeding season. Fortunately, these restricted areas include choice potential waterfowl sites where shallow inundation of the valley floor results in an alternating land and water arrangement with many low emergent ridges or natural levees. These sites afford excellent opportunities to dike off channels for enclosing back-water units that are well suited for marsh and aquatic habitat. The embayment areas of the reservoir, in these restricted zones, also provide opportunities to impound small shallow-water units of the farm-pond type advocated by the Soil Conservation Service.

The value of good feeding grounds for ducks adjoining large, comparatively sterile expanses of water is considerable. Large units of water attract waterfowl and serve as loafing sites, but adjoining feeding places of quality are necessary in order to hold the birds. This relationship has been exemplified on Hematite Lake, an impoundment on the Kentucky Woodlands National Wildlife Refuge. In 1944-46 ninety percent of this lake was open deep water and ten percent consisted of excellent marsh and aquatic vegetation, mainly in the upper shoal-water zone. At this time the whole lake was extensively used by ducks. These observations denote that in the TVA region the value of an area having useful marsh and aquatic vegetation may be increased ten-fold when complemented by an open expanse of water; and vice versa, the usefulness of a large open-water area is likely to be increased greatly by the presence of good food sources available in the immediate vicinity.

Propagation studies on marsh and aquatic plants in small water units were made with Preston Lane at the Kentucky Woodlands National Wildlife Refuge and later continued on an experimental sub-impoundment of the Kentucky Reservoir. Sowing of wild millet and largeseed smartweed improved the marsh margins. Longleaf pondweed was readily propagated by live-stem planting which resulted in aggressive growths that fruited profusely. Successful results were also obtained with narrow-leafed pondweed (Potamogeton pusillus), using winter buds for propagation. Introduction of watershield (Brasenia schreberi) was only partially successful. Plantings of rootstocks of this species were effective when made in water six inches or less in

depth. Propagation by seeding was successful in deeper water providing the bottom soil was soft enough to allow penetration of the initial roots and yet firm enough to furnish anchorage -- a rather critical requirement. At the Kentucky Refuge, the buoyant seedling leaves of watershield were observed tending to pull out plants that had insufficient anchorage. Sago pondweed (*Potamogeton pectinatus*)was unsuccessful on the Refuge and though it survived on the Kentucky Reservoir sub-impoundment, did not grow thriftily. Of the marsh plants, swamp smartweed was readily propagated by live-stem planting and produced luxurious growth that fruited heavily.

Protection of marsh and aquatic vegetation from depredations by rough fish needs immediate consideration in sub-impoundments that are subjected to overflow from the reservoir. Population studies in shallow areas on the Wheeler impoundments have shown that fish totalled 188 to 831 pounds per acre of which rough fish comprised 73% to 85% (Tarzwell, 1941). Fish control necessitates the building of outlet structures enabling complete drainage. Dewatering should be done during the rainy season when there is prospect of early reflooding. Withdrawing water from "permanent" impoundments during the growing season may not only cause a set-back to marsh and aquatic growths but, if protracted enough may also do harm by enabling the establishment of coppice, such as buttonbush. If dewatering is not possible, commercial fishing may help reduce rough fish populations. The beneficial role of commercial fishing on marsh and aquatic habitat is illustrated in nearby Reelfoot Lake where it has given practical protection to waterfowl habitat for years.

Seasonal Dewatered Units

In diked-off pool units operated by TVA, water is drawn off during the summer for malaria control and allowed to return during fall and winter. Under conditions such as these, the Tennessee Division of Fish and Game (Smith, 1948), the Tennessee National Wildlife Refuge, and cooperative farmers associations working with TVA have planted agricultural crops, part of which have been left in the field for waterfowl. Such units, when reflooded, attract a greater variety of ducks than do unflooded crop lands. Corn, soybeans, dwarfed grain sorghums, and buckwheat are readily taken by waterfowl when flooded.

Besides cultivated crops, native vegetation can be of considerable waterfowl value in these seasonally drained units. Particularly useful are water-tolerant oaks (*Quercus* spp.), and herbaceous plants, such as wild millet, rice cutgrass, squarestem spikerush, and the smartweeds.

Unfortunately, weed species also thrive in dewatered units and, unless curbed, crowd out the useful plants. Therefore, for success in such areas, control of undesirable species is a primary need. In scattered growth, spraying willow foliage with .5% 2,4-D during the time of maximum foliage yields over 95% control and does not harm rice cutgrass or wild millet. To prevent willow stumps from sprouting, painting or spraying with a 30% 2,4-D during the growing season has given over 95% control. These operations often allow desirable vegetation, such as wild millet and smartweeds, to spread and replace the willows. Rosemallow (*Hibiscus militaris*) also can be controlled by a July and August spraying of 2,4-D. Buttonbush can be eliminated or severely curtailed by a late August to September spraying

with ammonium sulfamate (DuPont's Ammate) at a concentration of 3/4 pound to a gallon of water (Steenis, 1950). For dense, extensive tracts of coppice, mechanical means of control may be more economical than herbicides. A heavy bush and bog disc or similar equipment can be used effectively late in the season when the ground is firm. In the case of high, woody growth, combinations of cutting and chemical treatment may be advantageous.

Control of cattails, particularly in seepage areas, can be of considerable value in increasing desirable marsh vegetation. In one locality, planting rootstocks of squarestem spikerush at three-foot intervals following cattail control resulted in a dense spikerush growth that discouraged initial establishment of cattail seedlings. Application of F. M. Uhler's control procedure has shown promise. This method consists of cutting the stems close to the ground when the cattail head is well formed, but not fully mature. A second cutting about a month later increases considerably the effectiveness of control. This procedure proved to be particularly successful if the first cutting was made under water.

In some places, a combination of upper and lower impoundments can be advantageous in supplying good food for waterfowl. In such arrangements, the upper pool serves as a reservoir to reflood the lower unit (or units). The lower unit may contain either agricultural crops or native marsh species. Since the upper reservoir retains its water until fall, useful aquatic vegetation may have opportunity to develop in it. Temporary stranding during the fall draw-down does not necessarily kill the plants. This combination arrangement results in a staggered use of the feeding units, the flooded crops or marsh of the lower units receiving waterfowl patronage first, with the reflooded marsh and aquatic plants in the upper reservoir being used later.

Providing Non-Flooded Farm Crops

Planting unflooded agricultural crops for use by ducks and geese has been extensively employed as a means of attracting waterfowl. The value of this type of management in the TVA area is confined almost entirely to mallards, black ducks, and Canada geese. The procedure ordinarily involves share-cropping with local farmers, the wildlife share being left in the fields. Corn, soybeans, dwarf grain sorghums, and peanuts, are readily accepted by these three species of waterfowl. Fall-planted grains such as wheat and rye, as well as the forage crop, Italian ryegrass, are of much value in furnishing browse for Canada geese. Larry Givens, refuge manager, and Tom Z. Atkeson of Wheeler Refuge also report that geese use crimson and white clover, alfalfa, and to some extent, bluegrass.

Controlling Erosion in Waterfowl Habitat

Destructive erosion of valuable waterfowl habitat occurs commonly in the shallow-water part of the TVA reservoirs where peninsulas and islands occur in an alternating land and water arrangement. Wave action and river currents augmented by changing water levels which, in some cases, exceed twenty feet, wash away and level-off much of the soil in these desirable

islands and peninsulas. Studies at the Wheeler and Kentucky reservoirs have shown that vegetation, particularly woody growth, can effectively retard such erosion. Here, existing trees and shrubs, where sufficient in density, restrain erosion along the old river bank. Plantings of fast-growing species, like black locust (Robinia pseudoacacia), mainly on the tops of the banks, and more water-tolerant species, chiefly willow, on the lower contours reduce the erosion process. Atkeson has pointed out that black locust has excellent soil-holding characteristics in its fibrous root system, and the ability to sprout readily from the roots. In the TVA lakes, with the exception of the Guntersville Reservoir, there is too much change of water level to allow effective retarding of erosion by perennial marsh vegetation, such as bulrushes, except when in conjunction with woody plants mentioned above.

Improving Islands and Mud Flats

Three types of habitat improvement for waterfowl can be conducted on islands and mud-flats. These are: planting agricultural crops, controlling woody competitors of native duck-foods, and sowing Italian rye-grass.

On the higher open areas, particularly on islands, short-period agricultural crops can be planted to advantage. This has been demonstrated by Parker Smith of the Tennessee Division of Game and Fish (1948) and by others. Late July and August plantings of dwarf grain sorghum and buckwheat have been effective in attracting geese and ducks.

The lower zone of growth on islands and mud-flats often inclines to become dominated by undesirable woody plants, mainly trumpetvine (Tecoma radicans). Cooperative studies with John Morse of the Kentucky Division of Game and Fish have revealed that this rapidly growing vine can be controlled by a spraying of .5% of 2,4-D (Steenis, 1950). On the Kentucky Reservoir this control has resulted in an increase of chufa. The period for successful spraying of trumpetvine (on TVA reservoirs) is at the time of maximum runner growth, usually in September. A single spraying has resulted in 95% control.

On the lower exposed mud-flat areas, Italian ryegrass can be planted with success when the nights become cool in the fall of the year, usually from mid-September into October. Such plantings of ryegrass have yielded excellent results in attracting and holding waterfowl in TVA reservoirs in Kentucky, Tennessee, and Alabama. Preliminary studies made by Givens and Atkeson of the Wheeler Refuge have indicated that this grass will withstand flooding for two to three weeks during the winter months. Canada geese readily graze in Italian ryegrass when it is either submerged or unflooded. Ducks, particularly baldpates, have been noted feeding on it to some extent when the plants are not flooded and take it readily when submerged. Coots have been attracted by it into areas where normally they do not stay.

Managing Marginal Marsh Vegetation

The marsh vegetation on reservoir margins is ordinarily not of much value for waterfowl if the water is drawn down below this zone during the season when large numbers of the birds are present. However, the stranded plants or their

seeds become available for use when there are sporadic winter refloods or when the water is high in the spring of the year, and at such times, they furnish a valuable supplemental food source. Crop plants for waterfowl have not always been sufficient to hold ducks in the lower TVA reservoirs. Prolonged flooding of marginal marsh growths in the upper reaches of the reservoirs has attracted large numbers of waterfowl additional to mallards, blacks, and geese.

Intensive studies on the management of impoundment margins were made in cooperation with Tom Z. Atkeson, biologist of the Wheeler Refuge, and Edwin Green, formerly CCC biologist, in 1940-41. Later they were continued independently by the writer. This program included over 150 plot studies on the propagation of waterfowl food and cover plants. Results of these investigations reveal that the squarestem spikerush can be planted with good results in the back-water areas. This brittle, naked-culm species will not withstand extensive wave action particularly when there are changing water levels. Propagation of the softstem bulrush (Scirpus validus) should be limited to areas where the fluctuation of water is not too severe, as in the Guntersville Reservoir. Southern bulrush (Scirpus californicus) can be introduced successfully and withstands wave action but it does not readily spread its zone of growth. Plants of the common three-square bulrush (Scirpus americanus) succeed along exposed sandy shorelines where wave action is too severe for other vegetation.

Propagating these perennial spikerushes and bulrushes has necessitated planting their rootstocks -- a laborious job and one which requires care for effective results. Long handled shovels have been found efficient for planting or "dibbling in" clumps of rootstocks. The latter should be planted shortly after being collected and spaced at intervals of one to three feet. Results of such plantings rarely show up well until the following season.

In the TVA impoundments, it was necessary to plant rootstocks at a period when the water was drawn down sufficiently to allow successful establishment of initial growth and permit survival after further lowering of the water. Suitable water levels for planting occur in late June or early July when the water has been drawn down a foot to eighteen inches. In reservoirs having weekly cyclical fluctuation combined with draw-down, plantings were most successful during the low period of the cycle when areas selected for planting became exposed. In sandy locations subject to wave action, best results with bulrushes were obtained immediately following emergence of the planting zone at the top of the cyclical fluctuation. This allowed rootstocks sufficient moisture to become established and prevented them from either being washed out or buried too deeply. After plants became well-established they were better able to withstand adverse conditions.

The disturbing of dominant vegetation on the margins, mainly purpletop grass, rosemallow, cattail, and woody growths, by bush and bog disking, plowing, or other means is sometimes advantageous in locations having slight grade. It opens the way for rapid growing pioneer plants valuable to waterfowl. Prominent among these are wild millet and annual smartweeds (mainly

Polygonum pensylvanicum). In the TVA area, these plants will volunteer, so seeding is rarely necessary.

Planting Aquatics

Effective propagation of aquatic or submergent vegetation for waterfowl in the TVA impoundments has been limited to the Guntersville Reservoir. Here water fluctuations are restricted, for the most part, to two feet and rarely three feet because of the requirements for navigation. Several good duck-food plants — mainly longleaf pondweed (*Potamogeton americanus*), southern pondweed (*P. diversifolius*), watershield (*Brasenia schreberi*), and southern naiad (*Najas guadalupensis*) -- have been noted growing in this reservoir. The last named, southern naiad, though useful to waterfowl, is considered a bad malaria-breeding plant and its propagation in TVA is not advisable. Watershield and longleaf pondweed have not been condemned by TVA's malaria control officials and, if given specific TVA approval, can be planted in areas suitable for their growth. Studies conducted in 1943 indicate that the longleaf pondweed can be easily introduced by live-stem plantings. However, extensive propagation of this species in Guntersville Reservoir was hampered by the limited changes in water levels that occurred. Concentrated treatment with 2,4-D was also injurious to this pondweed.

Summary

Impounding water in the TVA region opened up possibilities for developing valuable waterfowl resources. Creating new water bodies, especially fluctuating reservoirs, does not in itself necessarily add useful new waterfowl environment. It does, however, furnish a physical foundation upon which -- if opportunities permit -- good habitat for birds can be developed.

Capitalization on such opportunities has necessitated coordination of waterfowl management with TVA's multiple activities. Reconciling the development of waterfowl habitat with malaria control operations has been a primary problem. In some respects, however, the coordination of these seemingly conflicting objectives has not been as difficult as was anticipated. In some instances, procedures satisfactory for both malaria control operations and wildlife management have been developed. In connection with malaria control, such operations as water level fluctuation, larvicidal treatment, plant control, shoreline conditioning, diking and dewatering, require special consideration to avoid serious damage to waterfowl values.

The success of waterfowl habitat development in the TVA area has been confirmed by a marked influx of waterfowl. More particularly it has been demonstrated by the large numbers of birds present in improved areas as contrasted to their scarcity elsewhere. The following are methods of habitat improvement that were found especially effective in increasing waterfowl in the TVA region.

1. Constructing and managing sub-impoundments to develop either stable marsh and aquatic habitats or seasonally dewatered units in which agricultural crops are raised and subsequently flooded.

2. Producing unflooded agricultural crops to attract mallards, black ducks, and Canada geese.

3. Controlling destructive erosion in vulnerable parts of useful waterfowl habitat.

4. Increasing the usefulness of islands and mud flats by (a) raising short-period agricultural crops on higher places, (b) controlling trumpet-vine to allow better growths of chufa, and (c) sowing Italian ryegrass on the lower exposed mud flats.

5. Improving marginal marsh vegetation by controlling inferior species and introducing valuable ones.

6. Planting submerged aquatic vegetation in areas of limited fluctuation -- such as the Guntersville Reservoir.

REFERENCES

HALL, T. F., PENFOUND, W. T., and HESS, A. D.
1946. Water Level Relationships of Plants in the Tennessee Valley with Particular Reference to Malaria Control. Jour. Tenn. Acad. Sci., Vol. 10, No. 1, pp. 18-59.

HINMAN, E. H., STEENIS, J. H., KING, W. V., ROBERTSON, J. L., Jr., WIEBE, A. H., TARZWELL, C., and HESS, A. D.
1941. Additional Cooperative Studies of the Relations Between Mosquito Control and Wildlife Conservation. Science 94, pp. 44-45.

METCALF, R. L., HESS, A. D., SMITH, G. E., JEFFRY, G. M., and LUDWIG, G. L.
1945. Observations on the Use of DDT for the Control of Anopheles Quadrimaculatus. Public Health Reports, Vol. 60, No. 27, pp. 753-774.

ROZEBOOM, L. E., and HESS, A. D.
1944. The Relation of the Intersection Line to the Production of Anopheles Quadrimaculatus. Jour. of the Nat. Malaria Soc., Vol. 3, No. 3, pp. 169-179.

SMITH, P.
1948. Three Years of Waterfowl Management on TVA Power Reservoirs. Presented at the Southeastern Wildlife Conference, Lexington, Kentucky.

STEENIS, J. H.
1950. Studies on the Use of Herbicides for Improving Waterfowl Habitat in Western Kentucky and Tennessee. Jour. of Wildlife Management, Vol. 14, No. 2, pp. 162-169.

TARZWELL, C. M.
1941. Fish Populations in the Backwaters of Wheeler Reservoir and Suggestions for their Management. American Fisheries Soc., Vol. 71, pp. 201-214.

WIEBE, A. H.
1946. Improving Conditions for Migratory Waterfowl on TVA Impoundments. Jour. Wildlife Management, Vol. 10, No. 1, pp. 4-8.

WIEBE, A. H., and HESS, A. D.
1944. Mutual Interests of Wildlife Conservation and Malaria Control on Impounded Waters. Jour. Wildlife Management, Vol. 8, No. 4, pp. 275-283.

Interior - Duplicating Section, Washington 25, D.C. 85915